Cybernetics, Management Science, and Technology Policy

The Emergence of "Information Technology" as a Keyword, 1948–1985

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In November 1981, British prime minister Margaret Thatcher proclaimed 1982 as "Information Technology Year, IT-82." Her government aimed to reinvigorate the country's electronics industry to keep it from falling further behind the United States and Japan in the booming markets of microelectronics, computers, and telecommunications. To celebrate IT-82, the British government issued an IT stamp and commissioned an IT play and an IT ballet. In writing about these events, science journalist John Lamb attributed the concept of an "information society" to American mathematician Norbert Wiener, the founder of cybernetics. Lamb claimed that the phrase *information technology* was "coined only about two years ago."[1]

Lamb's attribution of the concept appears accurate: in *Cybernetics* (1948) and *The Human Use of Human Beings* (1950), Wiener had written about the coming of a "second industrial revolution" based on the processing of information in computerized, automated factories. Lamb was wrong about the coinage, however. The term *information technology* arose in management science in the United States in the 1960s, where it signified computer-based mathematical techniques designed to replace mid-level

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1. John Lamb, "IT 82—a Critical Year for Britain," *New Scientist*, 28 January 1982, 221.

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managers. By the early 1980s, several discourse communities—policy analysts, business writers, managers, information scientists, and social scientists—had transformed this knowledge-based meaning into the artifactual meaning described by Lamb. This contested process occurred during the 1960s and 1970s, a period of rapid change in computers and communications that formed the basis of what became widely known as *information technology*.[2]

In this essay, I ask why these discourse communities created the new term, and why it was selected for general use over the more common terms *information system* and *information retrieval*. In short, I ask what it meant to combine *information*, an ordinary word elevated to keyword through the popularity of cybernetics and the marriage of computers and communications, with *technology*, a much older keyword that had only recently acquired the meaning of a powerful social force.[3]

Before analyzing the discourse on *information technology* among business groups, social scientists, and policy analysts primarily in the United States, I will describe how *information* became a keyword in the physical and social sciences. My aim is not to adjudicate the various meanings of these words or provide yet another critique of the technological determinism that infused this discourse.[4] Instead, I will treat the diverse meanings as a resource for studying how and why a variety of communities helped to create and express the apparently new phenomena signified by *information* and *information technology*, as well as how and why they used techno-revolutionary language to promote new disciplines and technologies.[5]

2. Norbert Wiener, *Cybernetics: Or Control and Communication in the Animal and the Machine* (Cambridge, Mass., 1948); Norbert Wiener, *The Human Use of Human Beings: Cybernetics and Society* (New York, 1950). On discourse communities, see Ruth Oldenziel, *Making Technology Masculine: Men, Women, and Modern Machines in America, 1870–1945* (Amsterdam, 1999), introduction.

3. On the histories of the separate terms *information* and *technology*, see Rafael Capurro and Birger Hjorland, "The Concept of Information," *Annual Review of Information Science and Technology* 37 (2003): 343–411; Leo Marx, "Technology: The Emergence of a Hazardous Concept," *Social Research* 64 (1997): 965–88; Oldenziel, chap. 1; and the preceding article by Eric Schatzberg, "*Technik* Comes to America: Changing Meanings of *Technology* before 1930," *Technology and Culture* 47 (2006): 486–512.

4. See Merritt Roe Smith and Leo Marx, eds., *Does Technology Drive History? The Dilemma of Technological Determinism* (Cambridge, Mass., 1994); and Ronald Kline, "Technological Determinism," in *International Encyclopedia of the Social & Behavioral Sciences*, 3rd ed., ed. Neil J. Smelsa and Paul B. Baltes (Amsterdam, 2001), 12:15, 495–98.

5. This essay is part of a larger project on the history of cybernetics, information theory, and discussion about an information society in which I relate the professional discourses discussed here to those in the wider culture. On the use of the rhetoric of technological determinism in this manner, see Pablo J. Boczkowski, "Affording Flexibility: Transforming Information Practices in On-Line Newspapers" (Ph.D. diss., Cornell University, 2001), chap. 2.

Information as Keyword

In designating *information* and *information technology* as "keywords," I am applying the analytical framework developed by Raymond Williams in his cultural history of British society; however, I examine their meanings as used among professional groups, rather than in the wider culture that was the focus of Williams's work.

Williams identified certain terms—*culture*, *science*, *technology*, and *society* among them—as keywords in "two connected senses: they are significant, binding words in certain activities and their interpretation; they are significant, indicative words in certain forms of thought. Certain uses bound together certain ways of seeing culture and society, not least in these two most general words." Over time, *culture* came to encompass a variety of contested meanings. "These variations, of whatever kind, necessarily involve alternative views of the activities, relationships and processes which this complex word indicates. The complexity, that is to say, is not finally in the word but in the problems which its variations of use significantly indicate."[6]

Information has all the earmarks of a keyword. Its traditional meanings of the "action of informing" and "knowledge communicated concerning some particular fact, subject, or event" expanded dramatically with the development of electronic computers, satellite communications, and new information disciplines in the United States after World War II. The earliest of the new fields were cybernetics and the American school of information theory, a branch of applied mathematics based primarily on the work of Norbert Wiener at the Massachusetts Institute of Technology (MIT) and Bell Labs mathematician Claude Shannon. Later disciplines included computer science, library science, and information science.[7]

By 1970, discourse communities in academia, government, and business had given a variety of new meanings to *information*, which they usually then attempted to appropriate for their own discipline.[8] For physical scientists, communication engineers, and some social scientists, *information* was a mathematically defined, nonsemantic quantity related to "entropy"—what historian Katherine Hayles has referred to as the disembod-

6. Raymond Williams, *Keywords: A Vocabulary of Culture and Society*, rev. ed. (New York, 1983), 15, 92.

7. Fritz Machlup and Una Mansfield, "Cultural Diversity in Studies of Information," in *The Study of Information: Interdisciplinary Messages*, ed. Fritz Machlup and Una Mansfield (New York, 1983), 3–56. The definitions here are from the *Oxford English Dictionary* (*OED*), 2nd ed.

8. See Hans Wellisch, "From Information Science to Informatics: A Terminological Investigation," *Journal of Librarianship* 4 (1972): 157–87; Alvin M. Schrader, "In Search of a Name: Information Science and Its Conceptual Antecedents," *Library and Information Science Research* 6 (1984): 227–71; Fritz Machlup, "Semantic Quirks in Studies of Information," in *The Study of Information*, 641–71; and Capurro and Hjorland (n. 3 above).

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iment of information.[9] In the new fields of information science and management science, *information* was defined semantically as the middle term between "data" and "knowledge" in a hierarchy of cognition.[10] For all these groups, as well as those in business and policy-making, *information* was what was transmitted, stored, and processed by computers, communication systems, living things, and society.[11] Additionally, all groups defined *information* as being ubiquitous, even though these definitions differed both semantically (e.g., as a form of knowledge, or a meaningless string of bits) and materially (e.g., as a commodity, or a disembodied pattern transferred across the boundaries between biological and nonbiological entities). The growth of computers and data networks led many of these groups to identify *information* as the basis of a technological revolution that was creating a new age.[12] In summary, then, a variety of social groups usually expressed a variety of interpretations of *information* within a broad discourse that was held together by their common belief in its ubiquity and revolutionary character.[13]

During the 1950s and 1960s, the new discourse on information was stimulated by the popularity of Wiener's *Cybernetics* and *The Human Use of Human Beings*, and by the application, adaptation, and rejection of Shannon's nonsemantic theory of information.[14] Believing that the theory pro-

9. N. Katherine Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (Chicago, 1999), chap. 3. The classic sources for this definition of *information* are Claude E. Shannon, "A Mathematical Theory of Communication," *Bell System Technical Journal* 27 (1948): 379–423, 623–56; and Wiener, *Cybernetics* (n. 2 above), 76.

10. Machlup, "Semantic Quirks in Studies of Information," 642–49; and Thomas Haigh, "Inventing Information Systems: The Systems Men and the Computer, 1950–1968," *Business History Review* 75 (2001): 46–47.

11. See Edmund C. Berkeley, *Giant Brains: Or Machines That Think* (New York, 1949); Irwin Pollack, "Information Theory," in *International Encyclopedia of the Social Sciences*, 2nd ed., ed. David L. Sills (New York, 1968), 7:331–37; and Mark D. Bowles, "Liquefying Information: Controlling the Flood in the Cold War and Beyond," in *Cultures of Control*, ed. Miriam R. Levin (Amsterdam, 2000), 225–46.

12. See Wiener, *Cybernetics*, 155; and John Diebold, *Automation: The Advent of the Automatic Factory* (New York, 1952), 2, 90.

13. In stressing the variety of meanings of the keyword *information* in an overarching discourse, my approach differs from that of Lily Kay (*Who Wrote the Book of Life? A History of the Genetic Code* [Palo Alto, Calif., 2000]), who tends to flatten these differences in her Foucaultian analysis of an information discourse; and from that of Geof Bowker ("How to Be Universal: Some Cybernetic Strategies, 1943–1970," *Social Studies of Science* 23 [1993]: 107–27), who conflates discourses on information theory and cybernetics; and from that of Mark D. Bowles ("Crisis in the Information Age: How the Information Explosion Threatened Science, Democracy, the Library, and the Human Body, 1945–1994" [Ph.D. diss., Case Western Reserve University, 1999], 20–22), who regards the many postwar interpretations of *information* as too ambiguous and develops his own definition.

14. Kay, 78–91; and Ronald R. Kline, "What Is Information Theory a Theory Of? Boundary Work among Information Theorists and Information Scientists in the United

vided a quantifiable basis for investigating any type of communication, enthusiastic physical and social scientists applied it to a wide range of fields, including physics, statistics, artificial intelligence, behavioral and molecular biology, physiology, experimental and cognitive psychology, linguistics, economics, organizational sociology, communication studies, and library and information science.[15] Initially skeptical engineers successfully applied the esoteric theory to deep space communications in the 1960s.[16] Psychologist Irwin Pollack observed in 1968 that the

> molecule, the cell, the organ, the individual, the group, the organization, and the society have all been examined from the point of view of a general systems theory which focuses upon the information-processing, rather than upon the energetic characteristics of each system.[17]

Information was also a prevalent theme in business circles; but here, Shannon's theory was of minimal influence. While *Fortune* and *BusinessWeek* popularized the arcane theory, which was of paramount scientific interest during the mid-1950s, it was more typical for the business press to offer solutions to the perceived crisis of an "information explosion" that included automating the office with computers, information-retrieval systems, and management-information systems.[18] Government officials at

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States and Britain during the Cold War," in *The History and Heritage of Scientific and Technical Information Systems: Proceedings of the 2002 Conference, Chemical Heritage Foundation*, ed. W. Boyd Rayward and Mary Ellen Bowden (Medford, N.J., 2004), 15–28. On the origins of the theory, see William Aspray, "The Scientific Conceptualization of Information: A Survey," *IEEE Annals of the History of Computing* 7 (1985): 117–40; and Jérôme Segal, *Le Zéro et le Un: Histoire de la notion scientifique d'information au 20e siècle* (Paris, 2003), chaps. 2–3.

15. See Randall L. Dahling, "Shannon's Information Theory: The Spread of an Idea," in *Studies of Innovation and of Communication to the Public*, Stanford University, Institute for Communication Research (Palo Alto, Calif., 1962), 117–39; Colin E. Cherry, *On Human Communication: A Review, a Survey, and a Criticism* (Cambridge, Mass., 1957); Paul N. Edwards, *Closed World: Computers and the Politics of Discourse in Cold War America* (Cambridge, Mass., 1996); Donna J. Haraway, "The High Cost of Information in Post–World War II Evolutionary Biology: Ergonomics, Semiotics, and the Sociobiology of Communication Systems," *Philosophical Forum* 13 (winter–spring 1981–82): 244–78; Philip Mirowski, *Machine Dreams: Economics Becomes a Cyborg Science* (Cambridge, Mass., 2002); F. Craig Johnson and George R. Klare, "General Models of Communication Research: A Survey of Developments of a Decade," *Journal of Communication* 11 (1961): 13–26, 45; and Kline, "What Is Information Theory a Theory Of?"

16. E. N. Gilbert, "Information Theory after 18 Years," *Science* 152 (1966): 320–26; and Andrew J. Viterbi, "Information Theory in the Sixties," *IEEE Transactions on Information Theory* 19 (1973): 257–62.

17. Pollack (n. 11 above), 331.

18. See Francis Bello, "The Information Theory," *Fortune*, December 1953, 136–41, 149–51, 154, 156, 158; and Francis Bello, "Information: Now It's the Realm of Theorists," *BusinessWeek*, 30 July 1955, 58–60, 62, 64. See also Haigh (n. 10 above).

state and federal levels also worried a good deal about this so-called information crisis.[19]

Cybernetics was also important to a developing perception of the United States as an "information society," in which information, rather than matter or energy, was the key element of economic and social life.[20] This discourse began with Wiener's claim in *Cybernetics* and *The Human Use of Human Beings* that electronic, computerized control systems would form the basis of a "second industrial revolution" in which computers would be used for routine decision-making. Kurt Vonnegut's futuristic novel *Player Piano* (1952), in which computers ran factories and made political and economic decisions, helped to popularize the phrase, which Vonnegut attributed to Wiener.[21]

Although Wiener's two books emphasized the role of information in the functioning of animals, machines, organizations, and society, he did not explicitly identify it as the basis of a second industrial revolution. This was done by science writer Harry Davis in an article on computers published in *Scientific American* in 1949 in which he claimed that "[t]he 19th-century revolution was based on the transformation and transmission of energy. . . . The 20th-century revolution is based on the transformation and transmission of information." Davis probably drew heavily from *Cybernetics*, making explicit what Wiener had implied.[22]

In the early 1950s, a number of newspaper and magazine writers, including that venerable critic of capitalism Stuart Chase, commented on Wiener's predictions of a second industrial revolution, the scenario becoming a staple of the literature on automation.[23] By 1960, Henry Boettinger, a

19. Bowles, "Crisis in the Information Age" (n. 13 above), chap. 7; and Alvin F. Westin, ed., *Information Technology in a Democracy* (Cambridge, Mass., 1971).

20. In *The Modern Invention of Information: Discourse, History, and Power* (Carbondale, Ill., 2001), Ronald E. Day argues that the current information discourse comes from the merger of three historical strands: the European documentation movement; cybernetics and information theory; and today's discussions about the "virtual." I expand the first two strands to include many more discourses in science, engineering, and the social sciences.

21. Wiener, for his part, thought the book mediocre science fiction. Kurt Vonnegut Jr., *Player Piano* (New York, 1952), 12–13; and Wiener to Hope English, 17 July 1952, box 10, folder 153, Wiener Papers (hereafter WP), Institute Archives, Massachusetts Institute of Technology. On Wiener's usage, see *Cybernetics* (n. 2 above), 37–38; Wiener, *The Human Use of Human Beings* (n. 2 above), chap. 10. The term "second industrial revolution" dates to the 1920s, when it referred to electrification and the growth of the chemical industry; for its subsequent usage in the history of technology, see I. B. Cohen, *Revolution in Science* (Cambridge, Mass., 1985), 268.

22. Harry M. Davis, "Mathematical Machines," *Scientific American*, April 1949, 29 (cf. Wiener, *Cybernetics*, 37).

23. See Louis N. Ridenour, "Mechanical Brains," *Fortune*, May 1949, 109–10, 112, 114, 116–18; Peter Wyden, "Is Revolution of the Machine Coming?" *St. Louis Post-Dispatch*, 2 February 1950 (WP, box 25c, folder 379); Mark Starr, review of "*The Human Use of Human Beings: Cybernetics and Society* by Norbert Wiener," *Saturday Review of Liter-*

vice president at Michigan Bell, could tell a group of bankers: "It is one of the clichés of our literature that automation is accounting for the phenomenon known as the second Industrial Revolution."[24]

This budding discourse blossomed in the mid-1960s when prominent humanists and social scientists proclaimed the advent of a new type of society based on the processing of information. In *Understanding Media* (1964), Marshall McLuhan frequently spoke in terms of the flow of information in new communication technologies that led to what he called the "Age of Information."[25] Also in 1964, an early article by sociologist Daniel Bell featured his idea of a "post-industrial society."[26] In 1969, management guru Peter Drucker claimed that the "information industry" and "information revolution" were helping to create a "knowledge society" and "knowledge economy."[27] Economists heralded an "information revolution" and "information economy" during the 1970s.[28] Although Bell dismissed the term *information society* as an alternative to his own *post-industrial society* in 1973, he embraced the term in 1980.[29]

The multiple interpretations of *information* indicate what was at stake in developing new communication and computer technologies, creating new disciplines, and devising public policies after World War II. Various groups claimed the keyword *information* to demonstrate that they had the expertise to not only determine its scientific meaning, but also to reinterpret their own field in terms of information flow, to devise artifacts and systems to solve the information crisis, and to understand (and thus perhaps control) the essential commodity and technological basis for the coming

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ature, 19 August 1950, 15–16; Stuart Chase, "The Next Industrial Revolution: An Age of Machines That Think," review of *The Human Use of Human Beings*, by Norbert Wiener, *New York Herald-Tribune*, 20 August 1950, 5; Irwin Edman, "Mind in Matter," *New Yorker*, 14 October 1950, 124–26, 129; and "Inventor Says Automatic Machines Cannot Replace All Factory Hands," *New York Times*, 3 December 1952, 4.

24. Henry M. Boettinger, "The Place of Automation in History," *Data Processing* 2 (1960): 22.

25. Marshall McLuhan, *Understanding Media: The Extensions of Man* (New York, 1964), 36, 248, 264.

26. Daniel Bell, "The Post-Industrial Society," in *Technology and Social Change*, ed. Eli Ginzburg (New York, 1964), 44–59. This concept dates back to a liberal discourse of the late 1950s; see Howard Brick, "Optimism of the Mind: Imagining Postindustrial Society in the 1960s and 1970s," *American Quarterly* 44 (1992): 348–80.

27. Peter F. Drucker, *The Age of Discontinuity: Guidelines to Our Changing Society* (New York, 1969), 24–28, 261, 263.

28. See Donald M. Lamberton, ed., "The Information Revolution," special issue of *Annals of the American Academy of Political and Social Science* 412 (March 1974): 1–234; and Marc U. Porat, *The Information Economy: Sources and Methods for Measuring the Primary Information Sector* (Washington, D.C., 1977).

29. Compare Daniel Bell, *The Coming of Post-Industrial Society: A Venture in Social Forecasting* (New York, 1973), 37, with his "The Social Framework of the Information Society," in *The Computer Age: A Twenty-year View*, ed. Michael L. Dertouzos and Joel Moses (Cambridge, Mass., 1979), 163–211.

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information society. Rhetorically, adding the adjective *information* to such nouns as *theory*, *crisis*, *revolution*, *economy*, and *society* implied mastery over what was increasingly viewed as an unstoppable social force. With regard to *information technology*, the interpretation of *information* as being ubiquitous and revolutionary provided a resonant rhetorical resource for creating and revising the meaning of this new keyword.

Information Technology: Management Science or Industrial Art?

In the late 1950s—at the end of a decade of enthusiasm for cybernetics, information theory, and speculation about a "second industrial revolution" based on information processing—discourse communities in management and business introduced the phrase *information technology* and gave it two distinct meanings. Management scientists coined the term in 1958 to refer to a set of mathematical techniques that utilized the computer to assist, or even replace, mid-level management. Business groups began to use *information technology* in 1957 to refer to artifacts and systems. The two meanings drew upon prior usage of the keyword, *technology*. Management scientists adopted an older meaning of *technology* as knowledge, a variation on "the scientific study of the practical or industrial arts," that dated to the seventeenth century. Business groups, followed by policy analysts and social scientists, preferred the meaning of *technology* as artifacts and systems, a variation of "a particular practical or industrial art" that came into vogue after World War II.[30] By the early 1970s, the newer artifactual meaning replaced the older one of technique, as *information* came to be seen as a social force coursing through computer and communication systems.

The meaning of *information technology* as a management technique led a healthy life during the 1960s, although it largely disappeared in subsequent years. In late 1958, management professors Harold Leavitt of the Carnegie Institute of Technology (now Carnegie Mellon University) and Thomas Whisler of the University of Chicago predicted in a much-cited article in *Harvard Business Review* that management would be revolutionized during the 1980s by the computer and sophisticated mathematics. This "new technology," they said, referring to data processing, mathematical methods for decision-making such as operations research, and artificial intelligence, "does not yet have a single established name. We shall call it *information technology*." Tracing the origins of the proposed field to the new sciences of information theory, cybernetics, and game theory, Leavitt and Whisler expected companies to adopt such a (then) esoteric approach in

30. In "*Technik* Comes to America" (n. 3 above), Schatzberg gives an example from sociology that dates to 1937. The *Oxford English Dictionary* (*OED*), 2nd ed., s.v. "technology" dates these meanings to 1617 and 1957, respectively.

part for "its implicit promise to allow the top [management] to control the middle [management] just as Taylorism allowed the middle to control the bottom."[31]

In 1960, as editors of a work on the computer's effects on management, Whisler and his colleague George Shultz, then professor of industrial relations at the University of Chicago and later chief economic adviser and secretary of state under President Ronald Reagan, addressed "Information Technology and Management Organization," defining *information technology* more specifically than had Leavitt and Whisler in 1958. For Whisler and Shultz, the term included three areas: "(1) the use of mathematical and statistical methods, with or without the aid of electronic computers; (2) the use of computers for mass integrated data processing; and (3) the direct application of computers to decision-making through simulation techniques." Although computers were an important aspect of the new field, Whisler and Shultz followed Whisler's earlier usage and defined *information technology* as a management discipline, not as the artifacts and systems of the computer itself. They also coined the term "information technologists" to refer to those who applied the techniques of the new discipline, rather than to those who created computer hardware and software.[32] In 1962, they further clarified the relationship between computers and the new technique:

> Especially when combined with various mathematical and statistical methods and when applied to decision-making, rather than to simple clerical automation, the computer is the basis for a new information technology that may be a vital part of the way organizations are run in the future.[33]

Management specialists were excited about the proposed discipline of information technology popularized by Leavitt, Whisler, and Shultz in the 1960s. Leaders of management science, among them Herbert Simon at the Carnegie Institute of Technology, a colleague of Leavitt's at the institute's Graduate School of Industrial Administration, used the term in this manner. So did less-eminent figures such as John Burlingame, a consultant in operations research at General Electric.[34] In 1970, management consultant

31. Harold J. Leavitt and Thomas L. Whisler, "Management in the 1980s," *Harvard Business Review* 36 (1958): 41 (emphasis in original). This is the earliest usage cited by the *OED* (*OED*, 2nd ed., s.v. "information").

32. Thomas L. Whisler and George P. Shultz, "Information Technology and Management Organization," in *Management Organization and the Computer*, ed. George P. Shultz and Thomas L. Whisler (Glencoe, Ill., 1960), 3, 10–12.

33. Thomas L. Whisler and George P. Shultz, "Automation and the Management Process," *Annals of the American Academy of Political and Social Science* 340 (1962): 82.

34. Herbert A. Simon, *The New Science of Management Decision* (New York, 1960), 35; Herbert A. Simon, "Supplementary Comments," in *Management Organization and the Computer*, 61; and John F. Burlingame, "Information Technology and Decentralization," *Harvard Business Review* 39 (1961): 121–26.

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Edward Tomeski published *The Computer Revolution: The Executive and the New Information Technology*, crediting Wiener, Shannon, Simon, John von Neumann, and others with creating the elements of an "integrationist" approach to management that was based on information theory, communications, game theory, and feedback systems. The present meaning of *information technology* as artifacts and systems should not blind us to Tomeski's use of the term in the title of his book. For Tomeski, it referred to the computer-based management discipline advocated by Whisler: "*Information technology, as viewed by this book, is an important element of the integrationist school* . . . [it] consists of the disciplines of planning, systems design, systems analysis, operations research, and computer programming." The primary product that "information technologists" supplied to "administrators is information—information to facilitate and sharpen the administrator's functions."[35]

Management experts in the field of public administration also wrote about the new discipline of *information technology* and its distinctive terminology in the 1960s. Comments were not always favorable. New York urban planner William Levine observed that "information technology, primarily mathematical, seems, at least in the short run, to demand action counter to what human-relations research requires" in regard to participative management. Dwight Waldo, another critic, was concerned that a new technical elite would arise with "the rise of new management technologies, especially the burgeoning information technology." On the other hand, proponents of the technique waxed enthusiastic about its promise. William Gore, professor of government at Indiana University, argued that "though it is of little help in selecting the relevant facts, information technology holds the promise of a very much broader basis of fact in decision-making." Ida Hoos at the University of California at Berkeley stated that "[c]oupled with operations research, information technology provides quantitative methods for the analysis, simulation, model-building, and systems design that make possible large-scale projections and planning."[36]

Discourse communities outside management science and public administration adopted this usage of the new phrase in the early 1960s. To bring more science into business schools, California educator Albert Porter proposed a curriculum that included a course in "information technology" in 1963. In 1964, Gilbert Burck, a business writer who thought Leavitt and Whisler's predictions were rapidly being fulfilled, proclaimed in *Fortune*

35. Edward A. Tomeski, *The Computer Revolution: The Executive and the New Information Technology* (New York, 1970), 10 (emphasis in original).

36. William B. Levine, "Developments in Public Administration," *Public Administrative Review* 21 (1961): 54; Dwight Waldo, "Organization Theory: An Elephantine Problem," *Public Administrative Review* 21 (1961): 214–15; William J. Gore, "Developments in Public Administration," *Public Administrative Review* 22 (1962): 167; Ida Hoos, "Automation, Systems Engineering, and Public Administration," *Public Administrative Review* 26 (1966): 311.

magazine that "[a]s the power plant of the new so-called information technology, the computer is steadily raising high management's power to make accurate decisions."[37] In a study of work and leisure published in 1961, University of Michigan political scientist Harold Wilensky referred to the new field—which he identified as "computers, mathematical programming and operations research"—as one that was routinizing administrative jobs.[38] At this time, researchers in industrial and labor relations at the University of Illinois also began studying "such developments in industry as automation, programming, information technology, and other innovations in the management of both men and machines."[39]

Despite this attention, the meaning of *information technology* as a management discipline seems to have all but disappeared by 1970, Tomeski's *The Computer Revolution* being perhaps its last vestige. Large numbers of business and government entities adopted ever-more-powerful data-processing systems, but not the full range of mathematical decision-making techniques that Tomeski thought were revolutionizing management.

The change in the meaning of *information technology* is revealed by another management book published in 1970, Thomas Whisler's *Information Technology and Organizational Change*. One of the originators of the management meaning of the term, Whisler now changed direction and defined it as an industrial art—and the artifacts and systems produced by that art:

> Information technology is defined here as the technology of sensing, coding, transmitting, translating, and transforming information. More specifically, we are interested in the newest elements of technology—the computer and the program written for it, data-transmission networks, and sensing and translating devices such as optical scanners.

He did not refer to the previous uses of the term that he, Leavitt, and Shultz had promoted during the late 1950s and early '60s. Instead, he emphasized the computer element of his former interpretation; and, to place *information technology* in historical perspective, drew on the growing use of the keyword *technology* to refer to the products of an industrial art: "Information technology is as new as the computer and as old as the signal drum and the abacus."[40]

37. Albert Porter, "The Business-School Transition: From Folklore to Science," *Journal of Higher Education* 34 (1963): 139; Gilbert Burck, "Management Will Never Be the Same Again," *Fortune*, August 1964, 125.

38. Harold L. Wilensky, "The Uneven Distribution of Leisure: The Impact of Economic Growth on 'Free Time'," *Social Problems* 9 (1961): 50.

39. Solomon B. Levine, "News and Notes," *Industrial and Labor Relations Review* 14 (1961): 321.

40. Thomas L. Whisler, *Information Technology and Organizational Change* (Belmont, Calif., 1970), 11.

In elevating *information technology* to the category of a general technology, the latest version of which was represented by electronic computers and data networks, Whisler added his voice to a discourse that had arisen in the wider business community in the 1960s. In fact, however, the use of *information technology* to refer to an industrial art with its own artifacts and systems began somewhat before Whisler and Leavitt published their "classic" article in 1958. In 1957, the founders of a start-up company doing high-tech research and development called their new firm "Itek," short for information technology. The company produced photographic equipment for air force reconnaissance satellites and "graphic information storage and handling equipment" to process satellite data.[41] Similarly, two large defense contractors, Lockheed and General Dynamics, had established "information technology" divisions by the early 1960s.[42]

This use of *information technology* is evident in the writings of John Diebold during the 1960s. United States director of the International Cybernetics Association, founder of a management-consulting firm, admirer (and occasional critic) of Norbert Wiener, Diebold wrote articles and popular books on the coming age of automation.[43] Despite his profession, he rarely used the term *information technology* to denote a field of management science.[44] For him, it was the discipline—an industrial art that created such marvels as electronic computers, communication satellites, and lasers—that was "built upon the twin foundations of theory and of physical advances in electronics, optics, and other related sciences."[45] A 1967 advertisement for the Diebold Group's biweekly newsletter called it a publication for the manager "who is vitally concerned with the business significance of development in computer and information technology." Diebold predicted in 1969 that "[i]nformation technology is leading us to the construction of machines that exhibit most of what we have previously meant by 'intelligence'—machines that can truly be said to learn and

41. Established at Waltham, Massachusetts, with venture capital from Laurance Rockefeller, Itek held contracts from the Department of Defense as late as 1966. See Francis Bello, "How to Cope with Information," *Fortune*, September 1960, 165; "U.S. Sodium Flare Visible 700 Miles," *New York Times*, 18 August 1959, 8; "Other Sales, Mergers," *New York Times*, 21 June 1960, 43; "Seeburg and Itek Discuss a Merger," *New York Times*, 15 July 1960, 31 (quotation); "Itek Announces It Lost Contract," *New York Times*, 13 October 1966, 68; and Haigh (n. 10 above), 35n28.

42. See a notice in *Operations Research* 9 (1961): 602, and an advertisement in *American Mathematical Monthly* 68 (1961): U10.

43. Diebold, *Automation* (n. 12 above); and John Diebold, *Man and the Computer: Technology as an Agent of Social Change* (New York, 1969). For his praise of Wiener, see Diebold to Wiener, 6 May 1953 and 21 September 1953, WP, box 12, folders 172 and 178; for his criticism, see *Automation*, 151, 154, 155, 157.

44. See John Diebold, "Computers, Program Management, and Foreign Affairs," *Foreign Affairs* 45 (1966): 125–34.

45. John Diebold, "Application of Information Technology," *Annals of the American Academy of Political and Social Science* 340 (1962): 39.

machines that not only respond intelligently to speech commands but also speak."[46]

Other business writers spoke during the 1960s of *information technology* as an industrial art. In his best-selling book, *The Age of Discontinuity* (1969), Peter Drucker highlighted the recent growth of an "information industry" based on the computer, which, he admitted, was creating some technological unemployment. "But at the same time," Drucker reassured his readers, "the information technology also creates a great many more highly skilled and demanding jobs."[47] That same year, Carl Heyel marveled at the expansion of the new technology:

> It is clear that the new information technology—largely either computer based, computer related, or computer influenced—today reaches into all kinds and sizes of enterprises, in every conceivable industry and specialized activity, and with a multiplicity of options from which a user can choose whatever suits his particular needs.[48]

Also in the 1960s, the increasing use of computers for data processing led practitioners in such fields as accounting, insurance, and the legal profession, and at all levels of government, to include these monumental changes under the rubric of *information technology*, often doing so by considering the "impact" of the new technology on their respective fields.[49]

The situation was more complex in management science because of the competing meaning of *information technology* as a management discipline. Historian Thomas Haigh observes that in the 1960s, "systems men," who advocated the reform of management based on the computer, called their field "Management Information Systems" (MIS) instead of adopting Leavitt and Whisler's definition of *information technology*.[50] Indeed, management publications favored the term *information systems* until the 1980s, when the use of *information technology* finally became common.

Like Diebold and Drucker, however, many management specialists

46. *Datamation*, May 1967, 9 (advertisement); and Diebold, *Man and the Computer*, 6 (quotation). See also John Diebold, "What's Ahead in Information Technology," *Harvard Business Review* 43 (1965): 76–82.

47. Drucker (n. 27 above), 27. On fears of unemployment caused by automation, see Amy Sue Bix, *Inventing Ourselves Out of Jobs? America's Debate Over Technological Unemployment, 1929–1981* (Baltimore, 2000), chap. 8.

48. Carl Heyel, *Computers, Office Machines, and the New Information Technology* (New York, 1969), 10.

49. See Samuel Person, "The Integrated Use of Data-Processing Equipment in Teaching Accounting Subjects," *Accounting Review* 39 (1964): 473–75; Robert C. Goshay, *Information Technology and the Insurance Industry: The Impact of Electronic Data Processing on Managerial Processes and Insurance Functions* (Homewood, Ill., 1964); Reed C. Lawlor, "Information Technology and the Law," *Advances in Computers* 3 (1962): 299–352; and Westin (n. 19 above).

50. Haigh (n. 10 above), 35–36.

employed *information technology* to mean an industrial art. Hak Chong Lee at the State University of New York, Albany, for example, concluded his 1964 study of the influence of computers on organizational structure in shoe manufacturing by saying:

> There is no evidence in these findings to support the observation [made by other researchers] that information technology will bring a greater proportional reduction in managerial than in clerical manpower. . . . However, the effect on manpower of information technology is continuous.[51]

Although Andrew Vazonyi, a manager of electronic data processing at North American Aviation, used the term *information systems* extensively in a management journal article of 1965, he also used *information technology* in a general manner. "Information technology plays a significant role in man's current way of life and radical changes in the future are predicted by many," he said, predicting that "advances in Information Technology could perhaps dispense with the physical existence of the [New York] Stock Exchange."[52] Robert Head, an admirer (and occasional critic) of MIS, said in 1967: "In seeking to chart a course of action, management men sometimes become understandably confused about just what their systems people are trying to do in the field of information technology."[53]

The discourse of management experts in public administration followed a similar trend. The state of the subject during the late 1960s is seen in *Information Technology in a Democracy* (1971), a work edited by political scientist Alan Westin, which grew out of a research project Westin began in 1967 for Harvard's interdisciplinary Program on Technology and Society.[54] In this book, Westin published descriptions and critiques of the application of information technology by municipalities as well as by the U.S. State Department and the Department of Defense. Although it included an article by Harold Wilensky that used the management-discipline meaning of *information technology*, overall, the book indicated that the primary meaning of the term as used in public administration was that of an industrial art.[55]

51. Hak Chong Lee, "On Information Technology and Organizational Structure," *Academy of Management Journal* 7 (1964): 209–10.

52. Andrew Vazonyi, "Automated Information Systems in Planning, Control and Command," *Management Science* 11 (1965): B3, B7.

53. Robert V. Head, "Management Information Systems: A Critical Appraisal," *Datamation* 13 (1967): 27. For a reference to this article as an example of an information pyramid, see Haigh, 46.

54. Headed by philosopher Emmanuel G. Mesthene and funded by a $5 million grant from IBM, the program was founded in 1964 and ended in 1972. See George Basalla, "Addressing a Central Problem," *Science* 180 (1973): 582–84, and Matthew H. Wisnioski, "Engineers and the Intellectual Crisis of Technology, 1957–1973" (Ph.D. diss., Princeton University, 2005), 50–65.

55. Westin (n. 19 above), 1–11, 149–51; Myron E. Weiner, "Trends and Directions for Urban Information Systems," in Westin, 336–56; and Harold L. Wilensky, "The Road

In the 1960s, authors in the social sciences and humanities also began to speak of *information technology* in this way, especially when predicting the future. Ulric Neisser, a founder of cognitive psychology who worked at the MIT time-sharing lab Project MAC, foresaw a time when students would use widely available computer terminals in the home "to do their homework in every field—from history and Latin to information technology." More skeptically, political scientist Robert Pranger observed: "Disturbed by the potentialities of programmed information technologies, certain moralists, including the founder of cybernetics himself [i.e., Wiener], anxiously envisage mankind's prospects under ultra-rationalized, over-organized regimes."[56] Samuel Miles, a technical writer, defined the term broadly as "the art and science of creating and processing information" in order to identify his field with the more glamorous one of *information technology*.[57] Historians climbed aboard the bandwagon by embracing cliometrics. In 1967, a review of the application of computers to historical research predicted that "[m]odern information technology, and the automated data archives that this technology facilitates, will allow historians to use evidence of this sort more extensively and effectively, and in a more sophisticated and productive manner."[58]

Practitioners of the new field of "information science"—an amalgam of European documentation, specialized library science, and computer science, and thus a discipline in which a heavy use of *information technology* could be expected—began to call themselves "information scientists" after the American Documentation Institute (ADI) changed its name to the American Society for Information Science in 1968.[59] The paradox created by practitioners' continued preference for the phrases *information systems* and *information retrieval* may perhaps be explained by their adherence to the ideal of "pure science," in which basic science is viewed as the fount of all new technology.[60]

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from Information to Knowledge," in Westin, 277–86. Myron Weiner directed the Municipal Information Technology Program for urban managers at the University of Connecticut during the late 1960s.

56. Ulric Neisser, "Computers as Tools and as Metaphors," in *The Social Impact of Cybernetics*, ed. Charles R. Dechert (New York, 1966), 92; Robert L. Pranger, "The Clinical Approach to Organizational Theory," *Midwest Journal of Political Science* 9 (1965): 216–17.

57. Samuel A. Miles, "An Introduction to the Vocabulary of Information Technology," *Technical Communications* 14 (1967): 20–24.

58. Jerome M. Clubb and Howard Allen, "Computers and Historical Studies," *Journal of American History* 54 (1967): 604.

59. See Jesse H. Shera and Donald B. Cleveland, "History and Foundations of Information Science," *Annual Review of Information Science and Technology* 12 (1977): 249–75; and Irene S. Farkas-Conn, *From Documentation to Information Science* (Westport, Conn., 1990).

60. On this ideal, see Ronald R. Kline, "Construing 'Technology' as 'Applied Science': Public Rhetoric of Scientists and Engineers in the United States, 1880–1945," *Isis* 86 (1995): 194–221.

The pure-science ideal was also evident in the name and content of the *Annual Review of Information Science and Technology*, a journal established in 1966. In its first issue, Robert Taylor of the Center for Information Sciences at Lehigh University described the field as "divided into two areas: information engineering or technology and the information sciences," representing the applied and basic aspects of the profession.[61] Although the title of the review has remained unchanged, in the United States, *information science* has essentially replaced the longer *information science and technology*, possibly because many computer scientists, ex-physicists, and ex-chemists—who moved rapidly into the field during the 1960s—disliked being called "information engineers."[62]

A further indication of the staying power of the pure-science ideal is the term "information science(s) technology," coined in the 1960s. Here, *information science(s)* is an adjective for *technology*, which had the dual meaning of an industrial art and its artifacts.[63] Not surprisingly, this awkward neologism—which denoted the technology supporting the field of *information science(s)*—was the product of a government committee, the Committee on Scientific and Technical Information (COSATI), established in 1963 and reporting to President John F. Kennedy's Office of Science and Technology. In 1965, COSATI's panel on "Information Sciences Technology" was charged with coordinating research and development in government agencies to meet the threat of the Soviet Union's supposedly superior information-retrieval system.[64] By 1969, cold war–era educators Anthony Debons and Klaus Otten had developed a graduate course in information science at the University of Dayton, in Ohio, called "Information Science Technology."[65]

In such cases, it is possible that proponents of the term *information science(s) technology* selected it simply because they hoped to elevate their status through an explicit association with the ideal of pure science; but, in any event, the term did not catch on. During the 1960s and '70s, ADI's journal and annual review and its successor organization overwhelmingly favored *information system* and *information retrieval*, following the discur-

61. Robert S. Taylor, "Professional Aspects of Information Science and Technology," *Annual Review of Information Science and Technology* 1 (1966): 17.

62. John F. Harvey, "Professional Aspects of Information Science and Technology," *Annual Review of Information Science and Technology* 2 (1967): 419–44.

63. See Taylor, 20.

64. See John Sherrod, "National Information Issues and Trends," *Annual Review of Information Science and Technology* 1 (1966): 337–51; and William T. Knox, "The Government Makes Plans," *Physics Today* 19 (1966): 39–44. On the cold war threat, see Bowles, "Crisis in the Information Age" (n. 13 above), chap. 7.

65. Anthony Debons and Klaus Otten, "Foundations of a Concept for an Education Program in Information Science," *American Documentation* 20 (1969): 346–51. On Debons's cold war background, see William Aspray, "Command and Control, Documentation, and Library Science: The Origins of Information Science at the University of Pittsburgh," *IEEE Annals of the History of Computing* 21 (1999): 4–20.

sive practices in management science.[66] *System*, of course, was a popular term for large engineering projects, such as those of the cold war space program.[67] It also referred to a combination of hardware and organizational techniques that was attractive to status-conscious librarians.[68]

Information scientists thus did little to promote *information technology* as a keyword during the 1960s. There were some notable exceptions, however. The director of information sciences for an air force research unit used the phrase in 1961, as did Ralph Shaw, a prominent inventor of information-retrieval systems, in 1963. Both spoke in terms of a pure-science ideal in subjugating *information technology* to *information science*.[69] In 1964, Mortimer Taube, a leader in the field of computerized indexing, defined *information technology* as an information (rather than a management) discipline: "Information technology, as a profession, is concerned with the design, installation, and operation of information systems." When Taube titled his paper "The Coming of Age of Information Technology," he meant the rise of an information-science field, not the maturing of a technological system.[70]

The Policy of Information Technology: Artifacts and Systems as a Social Force

The meaning of *information technology* shifted with the advent of microprocessors, cable television, VCRs, fax machines, computer networks, and increased satellite communication during the 1970s and 1980s.[71] As

66. A search of titles of articles in *American Documentation* and its successor, the *Journal of the American Society for Information Science*, from 1955 to 1969, and of index entries in *Annual Review of Information Science and Technology* from 1966 to 1980, revealed a single reference to *information technology*. It appeared in the title of a report referred to in Edwin B. Parker, "Information and Society," *Annual Review of Information Science and Technology* 8 (1973): 345–73.

67. Thomas P. Hughes, *Rescuing Prometheus: Four Monumental Projects That Changed the Modern World* (New York, 1998).

68. See the broad definitions in Knox, 39; and Rowena W. Swanson, "Information System Networks: Let's Profit from What We Know," in *Information Retrieval: A Critical View*, ed. George Schecter (Washington, D.C., 1967), 5.

69. Harold Wooster, "Information Technology and the Information Sciences—'With Forks and Hope,'" in *Electronic Information Handling*, ed. Allen Kent and Orrin E. Taulbee (Washington, D.C., 1961), 279; and Ralph R. Shaw, "Information Retrieval," *Science* 140 (1963): 609.

70. Mortimer Taube, "The Coming of Age of Information Technology," *Bulletin of the American Medical Library Association* 52 (1964): 120; Taube's article was reprinted in *The Coming Age of Information Technology*, ed. Vladimir Slamecka (Bethesda, Md., 1965), 1–10. Although Slamecka dropped the first preposition "of" in adapting Taube's title to the book, he followed Taube in referring to information technology as a profession (p. v).

71. Michael Riordan and Lillian Hoddeson, *Crystal Fire: The Birth of the Information Age* (New York, 1997); Janet Abbate, *Inventing the Internet* (Cambridge, Mass., 1999); and

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technologies that processed information became more visible to professionals and the public, the management-science meaning of the term died out, as we have seen, leaving behind two related, dominant meanings: a specific industrial art, and the artifacts and systems produced by that art.

The latter meaning was often accompanied by the idea that since *technology* was a social force, *information technology* must be one as well. John Diebold stated this relationship as early as 1962: "This new technology will produce profound change in all human activity wherever information, its communication, and its uses occur. . . . Technology is truly an explosive agent of social change." Building on Wiener's concept of a second industrial revolution, Diebold thought that the current "technological revolution will run even deeper" than the first one. Like others who deployed the rhetoric of technological determinism in business, he advocated adopting the new technology in order to survive its predicted, sweeping social changes.[72]

While this shift in meaning of *information technology* to artifacts and systems in the 1970s occurred among all of the discourse communities examined in this essay, the shift was most striking when policy analysts talked about the future. An early example is a 1968 report on the proposed development of the Third World written by Lewis Bohn for the Hudson Institute. He explained that

> by "information technology" . . . we mean: TV, radio, motion pictures, teletype, telephone, sound recording equipment, facsimile systems, computers, information storage and retrieval systems, data links, teaching machines, radar, sonar, communication satellites of various kinds, and the like. We would not even exclude new means of printing books or periodicals. We refer not only to existing "conventional" systems and techniques, but to more advanced technology such as holography, lasers, and light pipes.[73]

This usage was common during the early 1970s when analysts called for political action at the national level. At Stanford University, Edwin Parker included a section titled "Information Technology Policy" in a summary paper on information and society that drew upon Daniel Bell's idea of a post-industrial society. Identifying such "key" information technologies as "cable television, communication satellites, computers, and a cluster of video technologies (tapes, cassettes, cartridges, disks)," Parker recom-

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Alfred D. Chandler Jr., and James W. Cortada, eds., *A Nation Transformed by Information: How Information Has Shaped the United States from Colonial Times to the Present* (New York, 2000), chaps. 6–8.

72. Diebold, "Application of Information Technology" (n. 45 above), 39, 45. Lawlor, for example, did use the term *second industrial revolution* (n. 49 above), 304.

73. Lewis C. Bohn, *Information Technology in Development* (Croton-on-Hudson, N.Y., 1968), 5. For an earlier example at NASA, see James E. Webb, "Decision-Making and Statistical Standards," *American Statistician* 19 (1965): 16.

mended that the federal government increase productivity by improving the "infrastructure of information technology." He and a colleague pushed the idea of an "information utility" that would allow the public to access information from home via cable TV. In a third paper published in the early 1970s, Parker drew on the then-new field of technology assessment:

> The assessment of information technology may be particularly significant because of the potentially far-reaching effects of changes in access to information on redistribution of political and economic power. . . . The sooner we study each new information technology, the greater the chance of being able to use the research results to influence policy in a meaningful way.[74]

Political scientist Nicholas Henry focused on the growing concerns about copyright issues. In the mid-1970s, he advocated changing copyright laws to catch up with such "information technologies" as "cable television, photocopying, and computer-based information storage and retrieval systems." Commenting on the passage of the new copyright act, he remarked in 1977 that "[w]ith the advent of new information technologies in the twentieth century, however, both the term and the concept of publication have lost their significance." Like Whisler in 1970, Henry and Bohn placed *information systems* under the more general, and seemingly more powerful, rubric of *information technology*.[75]

Another legal analyst worried about privacy, one of the "enormous long-range social implications [of the] new information technology."[76] Indicative of this trend was the establishment in 1973 of Harvard's Program on Information Technologies and Public Policy. Computer scientist and linguist Anthony Oettinger, who had criticized computers in education in an earlier project funded by Harvard's Program on Technology and Society, directed the new program.[77]

74. Parker, "Information and Society" (n. 66 above), 347, 356–57; Edwin B. Parker and Donald A. Dunn, "Information Technology: Its Social Potential," *Science* 176 (1972): 1,392–99; and Edwin B. Parker, "Implications of New Information Technology," *Public Opinion Quarterly* 37 (1973–74): 593–94. Later, in the early 1980s, the French government introduced a successful version of an information utility, the Minitel videotext system. See Amy L. Fletcher, "France Enters the Information Age: A Political History of Minitel," *History and Technology* 18 (2002): 103–17.

75. Nicholas L. Henry, "Copyright, Public Policy, and Information Technology," *Science* 183 (1974): 384; and Nicholas L. Henry, "The New Copyright Act, or How to Get into a Heap of Trouble without Really Trying," *PS* 10 (winter 1977): 6–7. See also Nicholas L. Henry, "Copyright: Its Adequacy in Technological Societies," *Science* 186 (1974): 993–1,004; and Bohn.

76. Arthur R. Miller, "Personal Privacy in the Computer Age: The Challenge of a New Technology in an Information-Oriented Society," *Michigan Law Review* 67 (1969): 1,089–1,246.

77. Emmanuel G. Mesthene, "Some General Implications of the Research of the

Diebold's techno-revolutionary language often accompanied the artifactual meaning of *information technology*. Parker spoke of a "revolution in information technology" in 1974.[78] That same year, Australian economist Donald Lamberton edited a special issue of the *Annals of the American Academy of Political and Social Science* titled "The Information Revolution," noting that in the 1960s, attention was "focused on the new information technologies—for example, computers and satellites—which seemed to symbolize the movement of society into a new industrial revolution: the information revolution." He also quoted Karl Marx's technologically determinist aphorism about the windmill producing the feudal lord and the steam engine, the industrial capitalist: "Today, we are attempting to analyze the beginnings of the information revolution . . . we seek to know what kind of society is being created by the computer, the satellite, television and a host of other devices to which we refer collectively as modern information technology."[79]

Policy analysts who used *information technology* to mean an industrial art also spoke in revolutionary terms. Cornell political scientist Ted Lowi began a 1975 paper by quoting from Vonnegut's *Player Piano*, which references Wiener's claim of an emerging "second industrial revolution." "There can no longer be any question that the industrial nations of the world are producing another technological revolution of historic importance," Lowi continued, adding that "[t]he trigger is the revolution in information technology."[80] In an article on war and peace in the information age, psychologist Anatol Rapoport at the University of Toronto also spoke of a second industrial revolution: "The possible positive contributions of the information revolution in alleviating other forms of human conflict depend upon the uses to which information technology will be put."[81]

The practice of combining the revolutionary meaning of *information* with the technologically determinist, artifactual meaning of *technology* in the compound-word *information technology* intensified during the 1980s when the term came into widespread use. My own informal survey found that the number of English-language books with *information technology* in their titles

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Harvard University Program on Technology and Society," *Technology and Culture* 10 (1969): 491; and Anthony G. Oettinger and Nikki Zapol, "Will Information Technologies Help Learning?" *Annals of the American Academy of Political and Social Science* 412 (1974): 116–26.

78. Parker, "Implications of New Information Technology," 592.

79. Donald M. Lamberton, "Preface," *Annals of the American Academy of Political and Social Science* 412 (1974): ix; Donald M. Lamberton, "National Information Policy," *Annals of the American Academy of Political and Social Science* 412 (1974): 147–48.

80. Theodore J. Lowi, "The Third Revolution, Politics, and the Prospect for an Open Society," *IEEE Transactions on Communications* 23 (1975): 1,019.

81. Anatol Rapoport, "War and Peace," *Annals of the American Academy of Political and Social Science* 412 (1974): 152. For similar talk about a new industrial revolution, see Herbert A. Simon, "What Computers Mean for Man and Society," *Science* 195 (1977): 1,186–91.

increased from six in the 1960s to sixteen in the '70s, and to twenty-five between 1980 and 1985.[82] One trend in the latter period was the identification of *information technology* with the rapid growth of microelectronics.[83]

With this history in mind, we can understand how Margaret Thatcher drew on a discourse that had been building up during the 1970s when she proclaimed 1982 as "IT-82"—"Information Technology Year"—in Great Britain. At the same time, she contributed to this discourse by popularizing the acronym *IT*, which was quickly picked up by academics.[84] British operations researcher Alec Lee used it extensively in 1983: his article comparing the electronics industries in Japan and the United Kingdom was confidently titled "The Age of Information Technology."[85]

Similarly, Tom Forester called his 1985 anthology of articles *The Information Technology Revolution*, thus indicating the growing popularity of the social-force meaning of *information technology*. Forester drew on a disciplinary meaning of the term in the introduction when he said that "[i]nformation technology in its strictest sense is the new science of collecting, storing, processing, and transmitting information." But in the book itself, he applied the term to artifacts and systems.[86] Several of the articles he reprinted, which dated from 1981 to 1984, used the term in this manner—most often as *information technologies*—when discussing education, business applications, development of the Third World, and impacts of intelligent machines on the workforce, sexual roles, and lifestyles.[87]

Critics raised their voices against the new technology in the mid-1980s, however. In the preface to a set of lectures posthumously published in 1985, British information theorist Colin Cherry stated that the purpose of these readings was

> to help student[s] argue [their] way through the clamour of reports and predictions and the frequent extravagant claims made for modern "information technology" (meaning, in the main, telecommunications

82. Based on a search for the exact phrase "information technology" in the Cornell University Library catalog and in the JSTOR collection of journals.

83. See Philip Sadler, "Welcome Back to the 'Automation' Debate," in *The Microelectronics Revolution: The Complete Guide to the New Technology and Its Impact on Society*, ed. Tom Forester (Cambridge, Mass., 1981), 293; and Juan Rada, *The Impact of Micro-Electronics: A Tentative Appraisal of Information Technology* (Geneva, 1980).

84. Richard L. Nolan attributes the acronym IT to Europeans; see his "Information Technology Management since 1960," in Chandler and Cortada (n. 71 above), 217.

85. Alec M. Lee, "A Tale of Two Countries: Some Systems Perspectives on Japan and the United Kingdom in the Age of Information Technology," *Journal of the Operations Research Society* 34 (1983): 753–63.

86. Tom Forester, ed., *The Information Technology Revolution* (Cambridge, Mass., 1985), xiii.

87. See the following in ibid.: Christopher Dede, "Educational and Social Implications," 243; David A. Buchanan, "Using the New Technology," 457, 465; Juan Rada, "Information Technology and the Third World," 571, 573; and Margaret A. Boden, "The Social Impact of Thinking Machines," 99.

and computing), and to examine what truth there may be in the idea that many today are calling the "Second Industrial Revolution," which they say is now upon us.[88]

Philosopher Langdon Winner argued that the enthusiastic talk about a forthcoming information society was an ideology of "mythinformation" that served the social groups promoting communication and computer systems, while Theodore Roszak called this discourse the "mumbo jumbo of a widespread public cult."[89]

Conclusion

In their recent article on the history of information as a concept, Rafael Capurro and Birger Hjorland note: "It is widely recognized that information theory is a problematic term, and that even the term *information technology* may be a misleading label for data technology or computer technology."[90] Rather than considering the different meanings and uses of these words as confusing or misleading, I interpret them as keywords. I have argued that the variety of meanings indicates contention among the social groups vying for control of the disciplines these words represented.

During the 1950s and 1960s, British and American mathematicians, physicists, electrical engineers, and social scientists debated the veracity of competing theories of information, their application to the physical and social sciences, and the nature of information itself.[91] The debates over the meaning of *information technology* from the late 1950s to the 1970s were less contentious. Management scientists drew on cybernetics and quantitative concepts of information to craft a new discipline, based on related mathematical techniques and the digital computer, that they called *information technology*. Business groups, social scientists, and policy analysts took a parallel discursive path, combining the new meanings of *technology* and *information* to create a different meaning of the term *information technology*: an industrial art that produces artifacts and systems having the power of a social force.

In using this phrase in lieu of, or in addition to, such alternatives as

88. Colin Cherry, *The Age of Access: Information Technology and Social Revolution—Posthumous Papers of Colin Cherry*, ed. William Edmonson (London, 1985), 12.

89. Langdon Winner, "Mythinformation," in *The Whale and the Reactor: A Search for Limits in an Age of High Technology* (Chicago, 1986), 98–117; and Theodore Roszak, *The Cult of Information: The Folklore of Computers and the True Art of Thinking* (New York, 1986), x. For an argument that beliefs in the mythology of information helped make its claims come true, see Geoffrey Bowker, "Information Mythology: The World of/as Information," in *Information Acumen: The Understanding and Use of Knowledge in Modern Business*, ed. Lisa Bud-Frierman (London, 1994), 231–47.

90. Capurro and Hjorland (n. 3 above), 390 (emphasis in original).

91. Kline, "What Is Information Theory a Theory Of?" (n. 14 above).

information systems and *information retrieval*, professional groups elevated *information technology* to a general historical category that included these rivals as the latest examples of *information technology*.

The fact that *technology* and *information* had independently gained the meaning of a social force strengthened this aspect of the new keyword. By the early 1980s, *information technology* was widely viewed as unstoppable. It was also seen as something that had to be cultivated if the United States and Europe were to survive the economic threat of Japan; had to be regulated if the rights of privacy and free speech were to be protected; and had to be mastered if a major overhaul of corporate management were to be prevented. *Information technology* formed the basis for the technologically deterministic theories of an "information society."[92] Condensing *information technology* to *IT* during the 1980s made the keyword even more abstract, to the point where it became even more autonomous in everyday speech. In many cases, this techno-revolutionary rhetoric signaled that technology was out of control. In making this claim, business consultants, policy analysts, and social scientists could then propose their own pet projects—whether management systems, public policies, or social theories—to solve such problems as the "information crisis."[93]

The dot-com boom of the 1990s set the stage for magnifying and transforming this rhetoric to a degree unimaginable in the 1970s, when technology was under fire from critics of the Vietnam War and the environmental movement. During the 1990s, *IT* became the engine for creating a supposed "new economy" beyond the old economic laws of capitalism. The dot-com crashes of 2000 and 2001 and the war on terrorism unleashed by 9/11 have dampened the techno-revolutionary rhetoric surrounding IT. Increasingly, *information technology* refers to a mundanely accepted part of everyday life, comparable to the telephone before the breakup of AT&T in the early 1980s. Even Nicholas Carr, a critic of IT who believes that money spent on information technology in business is not cost-effective, admits that IT is a vital part of a ubiquitous "information infrastructure."[94] It remains to be seen whether *information technology* will continue to be a keyword during the twenty-first century, or whether debates over its value will subside, thus eliminating its status as a keyword in the contested sense defined by Raymond Williams. IT has the advantage, however, of being composed of two keywords, *information* and *technology*, that have a history filled with heated debates over the meaning of these protean words.

92. Frank Webster, *Theories of the Information Society* (London, 1995), chap. 1.

93. See Bowles, "Crisis in the Information Age" (n. 13 above). On this theme, see also Langdon Winner, *Autonomous Technology: Technics-Out-of-Control as a Theme in Political Thought* (Cambridge, 1977).

94. Claude Fischer, *America Calling: A Social History of the Telephone to 1940* (Berkeley, Calif., 1992), chap. 1; and Nicholas G. Carr, "IT Doesn't Matter," *Harvard Business Review* 81 (2003): 41–49.